621

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PROCEEDINGS

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DISCUSSION OF PROCEEDINGS - SEPARATES

347, 404, 426, 461, 462

IRRIGATION AND DRAINAGE DIVISION

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Discussion of
"USE OF COLORADO RIVER WATER IN CALIFORNIA"

by Raymond Matthew
(Proc. Sep. 347)

RAYMOND MATTHEW,[1] M. ASCE.—Mr. Baker has brought into his discussion a number of extraneous subjects. As stated in the original paper the discussion of the complex legal issues between Arizona and California regarding the uses of Colorado River water are outside the scope of the writer's paper.

The factual and numerical material in Mr. Baker's second and third paragraphs are not particularly pertinent to the subject of the paper, which was the use of Colorado River water in California. Rights to such use are long established by appropriation and use in full accord with Western water law and by contract with the Secretary of the Interior under the Boulder Canyon Project Act. The first beneficial consumptive uses of Colorado River water in the Lower Basin were made by pioneers in the Palo Verde and Imperial Valleys long before Arizona became a state. Such uses only happened to be in California rather than in what later became Arizona. In the final analysis it is the rights of the water users which are at stake and not the rights of States as such. State officials are only the representatives and spokesmen for the individual or organized water users.

Although it is true that California's combined rivers now waste much water into the Pacific Ocean there is little physical or economic relationship between such discharge to the ocean and the amount of Colorado River water available to the Lower Basin or to California. Much of the discharge of California streams to the ocean is and always will be necessary for purposes of navigation, salinity control, carrying off wastes, etc. Even under maximum practicable development, it will be impossible to conserve and use all of the average runoff. But eventually, a much greater quantity of California's water resources will be put to use under plans now being studied by the State Engineer, and most of it will be needed and put to use in northern and central California.

For much of Southern California the Colorado River is the most economical or the only source of adequate supply. If ever water from northern California sources is brought into southern California it will only be at costs much greater than Colorado River water and at most will only supplement the local and Colorado River supplies. The total amount of all water that may be economically brought into southern California, including water from the Colorado River within California's legal rights, can never be more than a fraction of the potential ultimate water requirements of the area.

Mr. Baker fails to state that Hoover as well as Davis and Parker power plants also produce large amounts of cheap power for Arizona. He neglects also, to point out that in spite of the fact that 18% of the Hoover power was reserved for Arizona upon demand, California agencies and citizens were

1. Chf. Engr., Colorado River Rd. of California, Los Angeles, California.

required to underwrite the entire cost of Hoover Dam and Power Plant before construction could be authorized. California agencies have in fact invested or committed themselves to a total of over $500,000,000 for the power and river regulation of Colorado River, which incidentally are also of great benefit to Arizona.

In his fifth and sixth paragraphs Mr. Baker attempts to bring into the discussion questions over which there has been much disagreement. As stated above the debate of such issues is beyond the scope of the paper. It is certain however, that California attorneys would not agree with many of Mr. Baker's statements. The definition of surplus water, whether Arizona's contract is firm or even similar to and on an equal footing with those of California, and the method of accounting for evaporation losses are among the issues in the suit Arizona vs. California et al., pending in the U. S. Supreme Court. Argument of these issues in a forum such as the proceedings of the American Society of Civil Engineers would be improper, fruitless and pointless.

In conclusion, the writer regrets that one or more engineers connected with the several California agencies using Colorado River water did not participate in the discussion of his paper. Many interesting details regarding problems encountered in the construction and operation of the works could have been presented, which would be a valuable addition to the writer's paper that was necessarily limited to a relatively brief outline.

Discussion of
"IRRIGATION POTENTIALITIES IN ARKANSAS"

by Paul H. Berg
(Proc. Sep. 404)

C. O. CLARK,[1] A.M. ASCE.—The potentialities for irrigation in Arkansas and other Eastern States or humid areas, are undoubted, and not a new idea to the people of those states. The general measured facts and observations are similar to those determined and reported by engineers in Arkansas for a generation. The controversies known to this writer turn on whether it shall be done in accord with existing law or not in accord with existing law.

This discussion affirms that irrigation and agricultural use of water in Arkansas can take place "in accord with existing law." The authority mentioned under which the author traveled in Arkansas contained those words.[2] The author presented the position that the foremost problem "to be encountered is an adequate water code;" that is, to change from the existing law (See heading, "Problems: Water Code.")

This defines a wide difference in viewpoint of the problem. It defines an issue so vital, so full of social and political significance, that the people who observe this difference are careful about lining up on one side or the other on any lesser issue of technology, welfare, or profit, until they observe how they stand with respect to the existing law.

What evidence in Arkansas leads to the opinion that law is at fault? Does one compare or contest what may become an "opinion of the Supreme Court of Arkansas" or "in accord with the policy of the President," or assume that either will be premature or out of place?

Either, however, would be existing law as seen by some loyal adherents, and yet be poles apart as between strict interpretation of the Constitution of the United States in peacetime and the absolute powers of the Chief Executive in an unlimited state of national emergency.

During a time of difference, or doubt, perhaps both the Supreme Court of Arkansas and the Supreme Court of the United States would remain silent, and the attorneys-at-the-bar in Arkansas and the engineers as defined by Arkansas would follow the precedent established in the highest court in which they were licensed to appear. All eyes would watch to see where the President would choose to stand, because the water law of Arkansas is common law and a safe place to stand. All of which is in the nature of basic definition, perhaps loosely understood by most of us to mean to be very careful with words because we are talking about something that is very near to the nature of law itself and hardly within the realm of rights granted by law to those of us who can only appear in court but remain silent until something has been said. Not the least of those rights is to speak only in the official language of the State as taught in its schools or along whatever the chain is along the route to this court of initial jurisdiction and the place in which it is held. All

1. Registered Professional Engr., No. 2060, Tulsa, Okla.
2. Flood Control Act of 1950. Approved May 17, 1950.

of which, in the most extreme case, but one which exists between Brooklyn and Sante Fe, would place no dependable weight on a word spoken or printed outside the State, and certainly some burden of proof on anyone who chose to discuss or argue to prove first that there was anything at all in common, or different, or to argue about. Even a word.

But the author has inferred that a right to use water can exist and that an Arkansan may follow or not follow a choice that remains open. If this now be true, and a servant of the President wrote it, one could try to mention the Constitution, Amendments, Article X, and that the right, if any may be conceived, is in Arkansas or a citizen of that State or the source from which a citizen gets his powers. The Constitution of the United States provides a limited number of ways for depriving the citizen of those things, and prohibits all others. It guarantees against unreasonable search, security in person and papers, copyright on publication; yet there is enough confusion so that one hears oral publication of "secrets of the Government" which were personal papers so secured but now are for gift to allied aliens. Perhaps a good citizen just hides the rights he has so thoroughly that even a tourist cannot see them or find them; lawyers and engineers advise their clients how to proceed in safety, but need not tell what the law is, because each citizen knows the law of his own land, but not always the law of the stranger.

In the common law of water, which is the existing law of Arkansas, but not of Colorado, are rights to use which belong to bare-footed men and to riparian planters and even to strangers, and children yet unborn. These rights have been honored by sovereigns, and are unbroken by conquest for three centuries in Arkansas.

The writer knows of no court decision in Arkansas denying a right to reasonable use of water to a citizen, a peaceful alien, or a traveler, or denying another citizen reasonable reimbursement for reasonable action in that direction. But confiscation, expropriation, appropriation, sale and transfer of rights and authority to decide reasonableness to aliens and travelers is another question. Even limiting those rights to reasonableness measured by efficiency or economy would be an abridgement of an existing right. Some state legislators may, or may not, have limited their courts to the interpretations mentioned by the author. But the Supreme Court of Arkansas can follow "reasonable use" and the oldest and best of the doctrines of equity if amateur law-makers leave it alone.

Compared with western water law (only as regards applicability to the problems of Arkansas) the common law is more equitable and more realistic. At times, although this is not a characteristic of age, it has been more free. The Common Law does not promise court protection to a citizen in his attempt to restrain another citizen who has done no wrong, even by prejudging a set of facts that have not yet arisen in order to establish an inflexible code, or to give the judges' function to a loyal employee.

Such sound law leaves the flood waters of Arkansas abundantly available as potential property to the citizen who will capture, restrain, and control this public enemy, and it leaves the waterway open for him and his heirs to take that which they possess to market in a reasonable and safe way, even if it is liquid and water. This the engineers in Arkansas have reported as feasible in their plans to capture and deliver the excess flows. If an eye of the Federal Government remains on the water of the public highway, it may only be to keep some enterprising individual from tearing up the highway and the market place. If a Federal agent says the water is Federal property, some judge may ask him what language he speaks. If an engineer in that

State, who is sworn to uphold and defend such fine law, is skeptical of the future significance of a code, it may be because he doubts the present capacity of any existing engineer to tie the hands of a future judge. If he questions any out-of-state combination which advocates waiting for a change of State law, it may be because he is just impatient to resume the construction which can be completed under existing law.

Discussion of
"HUMID AREA SOILS AND MOISTURE FACTORS FOR IRRIGATION DESIGN"

by Fred H. Larson
(Proc. Sep. 426)

FRED H. LARSON,[1] M. ASCE.—The writer is grateful for the comments made by Mr. Hargreaves and Mr. Blaney and concurs with most of their remarks.

Moisture Level and Yield

Mr. Hargreaves refers to the moisture experiments by Veihmeyer and Hendrickson and states that they have found no significant differences in yields with levels of soil moisture. Thorne and Peterson, in their publication "Irrigated Soils" (Blakeston Press) on page 42, point out that many experimenters have found that production for many crops is greater for high moisture levels than for low moisture levels. The writer, through many years of observation and a considerable reading of the literature, believes that for most crops yields are higher for high moisture levels. Higher moisture levels for potatoes have an effect on quality as well as yield. Moisture levels also affect quality on other crops. Whether or not the extra cost involved in high moisture levels pays is a matter of economics and good management. It is agreed that there is probably an optimum level. In the original paper the writer pointed out that high moisture levels frequently require high fertilizer levels.

Moisture Availability from Soils

The writer has found the same variations in moisture holding capacity that Mr. Hargreaves points out.

Consumptive Use Coefficients

Chart No. 3 was devised to make a correction for consumptive use coefficients for short-term periods. Since Chart No. 3 was published, the writer has found that in the eastern United States there is considerable information which would support the idea of moving the curve a considerable distance to the right, probably as much as the 48 percent mentioned by Mr. Hargreaves.

Blaney-Criddle Formula

My apologies to Mr. Blaney for not going into detail in regard to the Blaney-Criddle formula. However, my excuse is that the Blaney-Criddle formula has practically become a household word among irrigators and normally no explanation is necessary. The Blaney-Criddle formula is a useful device in setting up irrigation guides; however, the material needs to be revised as irrigation experience is gained in any given locality.

The writer worked for a time in the Philippines and found that because of the uniformity of daylight hours and temperature the formula did not apply,

1. Regional Irrigation Engr., Soil Conservation Service, U. S. Dept. of Agriculture, Upper Darby, Pa.

which would indicate that stages of growth are also a factor in monthly consumptive use figures. However, the formula is extremely useful here in the Northeast.

Discussion of
"DIVERSION OF CANALS"

by Hassan M. Ismail
(Proc. Sep. 461)

SIR CLAUDE INGLIS,[1] M. ASCE.—The author under the heading "Previous Work" states, "Although many engineers have discussed this problem, very few experiments have been done in the laboratory." This statement is quite incorrect. The author is referred to Chapter 6 (pp. 217-279) of "The Behaviour and Control of Rivers and Canals (with the aid of models)," obtainable from the Publication Branch, General Department, India House, Aldwych, London, W.C.2., which besides linking model and field results, gives many references to work done at the Central Waterpower Irrigation and Navigation Research Station, Poona and other Stations in India where silt regulation model experiments were looked upon as routine tests prior to construction.

HAROLD TULTS.[2]—The laboratory work done by Professor Hassan M. Ismail is one of the rare attempts to isolate the effect of a factor, in this case the velocity ratio in main and branch canal, upon the development of the flow separation and secondary currents in diversion intakes. Unfortunately, the occurrence of separation is one of the most complex hydraulic phenomena, which may be caused not only by velocity ratio but also by other factors.

The writer, having carried out laboratory experiments about flow expansion in unilateral diverging closed conduits,[3] attempts to analyze the velocity ratio effect upon the flow pattern from a different angle (another point of view).

Many diversions are designed, often unintentionally, so that they act as flow expansions with inherent tendency toward separation. In Fig. 1 the possible locations of separations in a bad diversion layout are shown. If the wetted section of approach canal is increased considerably in the diversion section, separations are unavoidable, even when streamlining the embankments.

In the above mentioned experiments, the writer found that the separation boundary in a flow expansion in closed conduits does not vary either with angle of divergence or with flow velocity.

Investigating the results of experiments by the author, some interesting conclusions may be drawn regarding the extent of separation.

1) The separation did not vary with the change of velocity ratio when the flow velocity in the branch canal was higher than in the approach canal, $\frac{V_m}{V_b} < 1$, as demonstrated by Runs No. 1 and No. 2 in Table No. 1.

1. Director of Hydr. Research Station, Dept. of Scientific and Industrial Research, Wallingford, Berkshire, England.
2. Asst. Hydr. Engr., Pioneer Service and Eng. Co., Chicago, Ill.
3. "Flow Expansion and Pressure Recovery in Fluids," by Harold Tults, Proceedings—Separate No. 567, ASCE, December, 1954.

Unfortunately, in all other diversion set-ups only one run in each with a velocity ratio smaller than one was carried out. Nevertheless, the writer is convinced that the effective width in each branch would be constant as long as the velocity in the approach canal would not exceed the one in the branch canal.

2) At the velocity ratios smaller than one, the relative effective flow section in the branch canal was the greater, the narrower the width of the branch canal, as shown in Table No. 2 where the runs with velocity ratios smaller than one are arranged according to the branch widths (the width of the main canal is kept constant).

Table No. 2

Run No.	Width b_b cms	Angle of Twist θ	$\frac{V_m}{V_b}$	Effect, Width b' cms	Relat. effect. width %	Spiral Strength S_b %
1	15	90	0.58	10.3	69	29
2	15	90	0.83	10.4	69.5	37
11	13.5	72	0.74	10.o	74	8
5	10	90	0.60	8.0	80	40
7	9	108	0.60	6.8	75.5	33
9	8.5	72	0.52	7.1	83.5	27

3) The Runs No. 3, 4, 6, 8, 10, and 12, with high $\frac{V_m}{V_b}$ ratios, induced strongly bulging separations. As mentioned above, the separation caused by abrupt boundary changes and by flow expansion should not expand with velocity variations. This contradiction requires an explanation, which the writer hopes to present by observations and deliberations.

As laboratory experiments by Professor Th. Rehbock[4] disclosed, it was possible to eliminate separation by streamlining of intake corners, but only when the velocity in the diversion was equal to or higher than the velocity in the river. During floods, the approach velocity exceeded the normal velocity considerably. The water level in the river was kept constant by means of control works of the near-by dam. The formerly separation-free intake with streamlined embankments became partly filled by rollers on both sides. The gaging of the water level in the diversion conduit indicated a reduction of the slope, i.e., a conversion of the kinetic energy of inflow into the static one. Apparently, the available energy head was not sufficient to convey the full inflow through the conduit and separation was induced, which reduced the inflow in the diversion. This could be another cause to generate separations, additional to the abrupt boundary change and flow expansion in divergent canals.

The author did not provide in his paper any data about the slope and the control situation in the diversion branch. Presumably, in order to reduce the velocity in the branch, he had to reduce the water surface slope in it, with a

4. "Report about Diversion Improvements for Powerplant Hagneck on River Aare." Karlsruhe. Not published.

collateral effect that similar discrepancies between the inflow and the discharge capacities of the diversion intake and control weir may have occurred. In this situation nature would assume control of the flow and induce separations, constricting the inflow in order to maintain the energy balance.

The situation may be improved by contraction of the intake section itself. In this way, the entering flow would be reduced. The final regulation of energy head would be performed by the separation in the expanding transition to the normal conduit section, in some distance from the intake, where the possible flow separation cannot affect the sediment transport any more.

The writer does not attribute the entire increase of separation in diversions at slow velocities to natural self-regulation. The separation may be caused by a combination of factors. It would be difficult to separate the ratio of contribution of each factor shaping the separation. The only criterion would be the fact that self-regulation is absent when the width of the separation is not affected by the velocity variation.

These speculations, deduced from experimental work about the separation phenomena in closed conduits and assumed to be valid also in open conduits, are not verified by systematic tests with flow diversions. They explain the controversy about the variable extension of the separation boundary in flow diversions. Systematic attack in the laboratory will be very helpful in the solution of this problem.

Mr. Hassan states that many engineers have discussed the diversion problem, but few experiments have been done in laboratories. This is not quite true; there has been extensive experimental work done covering such factors as alignment curvatures, deflection angle, canal widths, bottom erosions, etc. However, all these reports may not be available in English. H. Bulle[5] has investigated the effects of deflection angle, canal width, streamlining of corners, and surface depression on sediment transport into the diversion. He also found that adding sand in a sediment-free diversion will reduce the width of the separation. Extensive laboratory work has been done by H. Habermaas[6] regarding the location of diversions in the curve, and sediment intake for non-erodible and erodible beds. F. Schaffernack[7] has also studied these factors in the laboratory, particularly as related to the sill effects. A. Schoklitsch[8,9] investigated the effect on different sill layouts on sediment intake for power diversions on the Mur river in Austria, in model and in prototype.

It would go beyond the scope of this discussion to explain all the results of those investigations. But it would serve the problem to make a concise summary of the most important factors affecting sediment entrance.

1) The best position for a diversion is tangential at the end of the concave side of a river bend.
2) Smaller entrance width reduces sediment intake.

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5. "Untersuchungen über die Geschiebeableitung bei Spaltung von Wasserläufen," V.D.I. No. 283, 1929.
6. "Geschiebeeinwanderung in Werkkanal und deren Verhinderung," Wasserkraft und Wasserwirtschaft, Heft 9, 10, 1935.
7. "Untersuchungen über Wasser- und Geschiebebewegung bei freien Werkseinfängen," Die Wasserwirtschaft, 1930, p. 635.
8. "Geschiebebewegung in Flüssen und an Stauwerken," Verlag Springer Wien, 1928.
9. "Hydraulic Structures," American Society of Mechanical Engineers, 1937.

3) Streamlining of entrance corners reduces separation, depression of water surface, and sediment transport into the diversion.
4) A smaller diversion ratio reduces the sediment intake.
5) Sediment transport into the diversion is not affected by the entrance velocity as found by Schoklitsch.[10]
6) Sills and apron walls are useful for reducing sediment intake. A sill, to be effective, usually requires constant or intermittent sluicing. A sill in a straight- or convex-bank location should be higher at the upstream end and in a concave-bank location higher at the downstream end to keep out the concentrated flow of sediments in these places.
7) Inclination of the entrance sill relative to the axis of main canal, induces a concave-curve action and helps to deflect the sediment flow.
8) Scours close to the diversion would change the flow conditions considerably.

Professor Hassan M. Ismail, concentrating his work on each factor that may affect the disproportionate inflow of sediments into the diversion canal, separately, is on the right path toward solving this complex problem. It is extremely important for Egyptian irrigation engineers to be able to build efficient irrigation works, as the existence of Egypt has depended upon irrigation since ancient times.

10. See Footnote 8 on page 11.

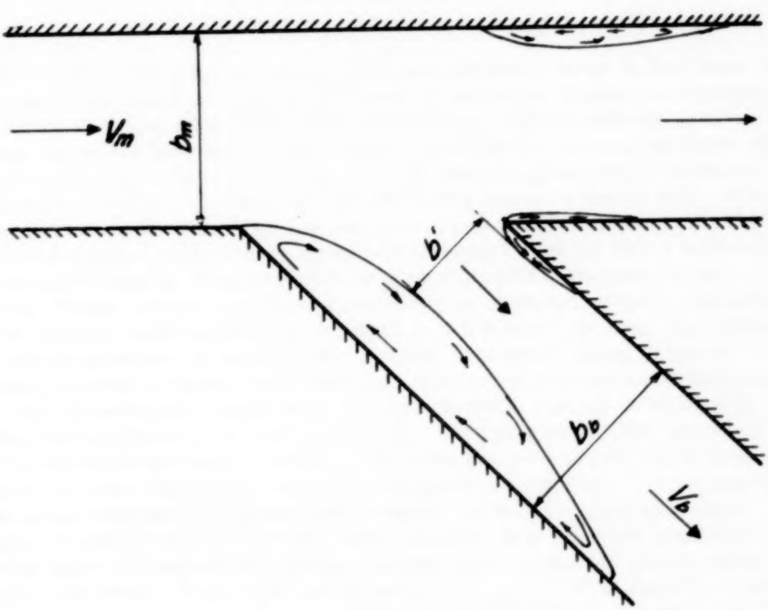

Fig. 1 Flow Separation in Diversion

Discussion of
"FACTORS INFLUENCING IRRIGATION IN HUMID AREAS"

by Tyler H. Quackenbush
(Proc. Sep. 462)

ALFRED R. GOLZE,[1] M. ASCE.—Mr. Quackenbush early in his paper calls attention to the apparent high inefficiency of irrigation systems measured by the per cent of available water utilized by crops. The engineers part in reducing this water loss in gravity systems, and thereby increasing their efficiency is limited to that part of the system that brings water to the farm. Once water reaches the farm the responsibility shifts to the farmer. Records of the Bureau of Reclamation, for example, show system losses from the source of supply (reservoir or stream diversion) to the farmer's turn-out run to an average of 30-40 per cent on major projects operated by the Bureau. These losses represent a combination of waste, seepage and evaporation in gravity canal and lateral systems in the Western States. The Bureau has had in operation for some years a lower cost canal lining program designed to reduce losses from seepage. This program has made progress and many Government canals have been lined with a variety of materials testing their efficiency as sealing devices. Concrete is still the principal sealing agent on the larger canals. The reduction or elimination of waste is a matter of operating water control under good management. There appears to be some relationship between the adequacy of water supply and water losses. Projects that have ample water supplies may be more liberal in running water through their systems so that water is wasted which, under drought conditions, would have undoubtedly been saved. The sprinkler irrigation systems in the humid areas operating with closed pipe lines from their sources of supply are not subject to major losses such as in the open ditches of the West. Sprinkler system losses arise more in the operation stage, such as through over irrigation.

Mr. Quackenbush's paper points out a number of problems connected with bringing irrigation into the humid part of the country. This expansion of irrigation and its problems is not going unnoticed by the public press as witness the detailed discussion on sprinkler irrigation which appeared in the Wall Street Journal on September 2, 1954.

The writer certainly agrees with Mr. Quackenbush that the engineering experiences of the West should be opened to the East. One of the greatest benefits the engineering profession can contribute to solving the problems of irrigation in the Midwest and East is to apply its experience in the design and operation of systems in the Western States. The lack of basic data on the behavior of soils under varying water tables and application of irrigation water in the humid area are serious deficiencies. If there is unpublished data in the files of the engineering profession, it would certainly be helpful if arrangements could be made for its publication. In the West drainage, for

1. Director of Programs and Finance, Bureau of Reclamation, U. S. Dept. of the Interior, Washington, D.C.

example, is usually a matter of handling return flows from irrigation during a period of little natural precipitation. In the Midwest and East maximum precipitation could occur at the same time the water table is high from irrigation. There are possibilities of increasing the flood hazards if irrigation becomes widespread.

It seems inevitable, as the demand for irrigation increases in the humid area, that there will be a banding together of farmers into districts or companies to finance the construction of facilities. Such facilities would provide a source of dependable water, not only for riparian use, but for in-land use. The engineering experience gained in the Western States should be of considerable assistance when this point of development is reached.

Another experience that the West can contribute to the East, which Mr. Quackenbush mentions, is the adjustment of State laws to control the legal use of water for irrigation purposes. The laws of nearly all Western States have been modified during the past century to meet the changing needs of an irrigated agriculture. Whether substitution of the appropriation theory for the riparian theory will be the answer east of the 100th meridian remains to be seen. The formulation of irrigation districts or the bringing of irrigation activity into the existing soil conservation or drainage districts may be the solution. It is through local organizations, such as these, that farmers can obtain effective answers to their engineering, farm economics, and legal problems. Increasing pressure on the use of water supplies in areas subject to drought will probably be the incentive to inspire the formulation of such districts or modification of existing ones, to secure such action as may be required.

It is understood that the book on "Selected Problems in the Law of Water Rights in the West," published by the U.S. Department of Agriculture in 1942, under the direction of Mr. Wells A. Hutchins, is being revised and will treat the legal problems of each Western State separately. This book should be a valuable aid to the humid areas of the country in working out the legal problems that will confront them as irrigated agriculture expands and uses more and more of this limited resource.

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

VOLUME 80 (1954)

FEBRUARY: 398(IR)[d], 399(SA)[d], 400(CO)[d], 401(SM)[c], 402(AT)[d], 403(AT)[d], 404(IR)[d], 405(PO)[d], 406(AT)[d], 407(SU)[d], 408(SU)[d], 409(WW)[d], 410(AT)[d], 411(SA)[d], 412(PO)[d], 413(HY)[d].

MARCH: 414(WW)[d], 415(SU)[d], 416(SM)[d], 417(SM)[d], 418(AT)[d], 419(SA)[d], 420(SA)[d], 421(AT)[d], 422(SA)[d], 423(CP)[d], 424(AT)[d], 425(SM)[d], 426(IR)[d], 427(WW)[d].

APRIL: 428(HY)[c], 429(EM)[c], 430(ST), 431(HY), 432(HY), 433(HY), 434(ST).

MAY: 435(SM), 436(CP)[c], 437(HY)[c], 438(HY), 439(HY), 440(ST), 441(ST), 442(SA), 443(SA).

JUNE: 444(SM)[e], 445(SM)[e], 446(ST)[e], 447(ST)[e], 448(ST)[e], 449(ST)[e], 450(ST)[e], 451(ST)[e], 452(SA)[e], 453(SA)[e], 454(SA)[e], 455(SA)[e], 456(SM)[e].

JULY: 457(AT), 458(AT), 459(AT)[c], 460(IR), 461(IR), 462(IR), 463(IR)[c], 464(PO), 465(PO)[c].

AUGUST: 466(HY), 467(HY), 468(ST), 469(ST), 470(ST), 471(SA), 472(SA), 473(SA), 474(SA), 475(SM), 476(SM), 477(SM), 478(SM)[c], 479(HY)[c], 480(ST)[c], 481(SA)[c], 482(HY), 483(HY).

SEPTEMBER: 484(ST), 485(ST), 486(ST), 487(CP)[c], 488(ST)[c], 489(HY), 490(HY), 491(HY)[c], 492(SA), 493(SA), 494(SA), 495(SA), 496(SA), 497(SA), 498(SA), 499(HW), 500(HW), 501(HW)[c], 502(WW), 503(WW), 504(WW)[c], 505(CO), 506(CO)[c], 507(CP), 508(CP), 509(CP), 510(CP), 511(CP).

OCTOBER: 512(SM), 513(SM), 514(SM), 515(SM), 516(SM), 517(PO), 518(SM)[c], 519(IR), 520(IR), 521(IR), 522(IR)[c], 523(AT)[c], 524(SU), 525(SU)[c], 526(EM), 527(EM), 528(EM), 529(EM), 530(EM)[c], 531(EM), 532(EM)[c], 533(PO).

NOVEMBER: 534(HY), 535(HY), 536(HY), 537(HY), 538(HY)[c], 539(ST), 540(ST), 541(ST), 542(ST), 543(ST), 544(ST), 545(SA), 546(SA), 547(SA), 548(SM), 549(SM), 550(SM), 551(SM), 552(SA), 553(SM)[c], 554(SA), 555(SA), 556(SA), 557(SA).

DECEMBER: 558(ST), 559(ST), 560(ST), 561(ST), 562(ST), 563(ST)[c], 564(HY), 565(HY), 566(HY), 567(HY), 568(HY)[c], 569(SM), 570(SM), 571(SM), 572(SM)[c], 573(SM)[c], 574(SU), 575(SU), 576(SU), 577(SU), 578(HY), 579(ST), 580(SU), 581(SU), 582(Index).

VOLUME 81 (1955)

JANUARY: 583(ST), 584(ST), 585(ST), 586(ST), 587(ST), 588(ST), 589(ST)[c], 590(SA), 591(SA), 592(SA), 593(SA), 594(SA), 595(SA)[c], 596(HW), 597(HW), 598(HW)[c], 599(CP), 600(CP), 601(CP), 602(CP), 603(CP), 604(EM), 605(EM), 606(EM)[c], 607(EM).

FEBRUARY: 608(WW), 609(WW), 610(WW), 611(WW), 612(WW), 613(WW), 614(WW), 615(WW), 616(WW), 617(IR), 618(IR), 619(IR), 620(IR), 621(IR)[c], 622(IR), 623(IR), 624(HY)[c], 625(HY), 626(HY), 627(HY), 628(HY), 629(HY), 630(HY), 631(HY), 632(CO), 633(CO).

c. Discussion of several papers, grouped by Divisions.
d. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
e. Presented at the Atlantic City (N.J.) Convention in June, 1954.

AMERICAN SOCIETY OF CIVIL ENGINEERS

OFFICERS FOR 1955

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